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CRANBERRY LAKE, CROW WING COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
National Environmental Research Center
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NATIONAL EUTROPHICATION SURVEY

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT
ON
CRANBERRY LAKE
CROW WING COUNTY
MINNESOTA

EPA REGION V

WORKING PAPER No. 138

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

JULY, 1975

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

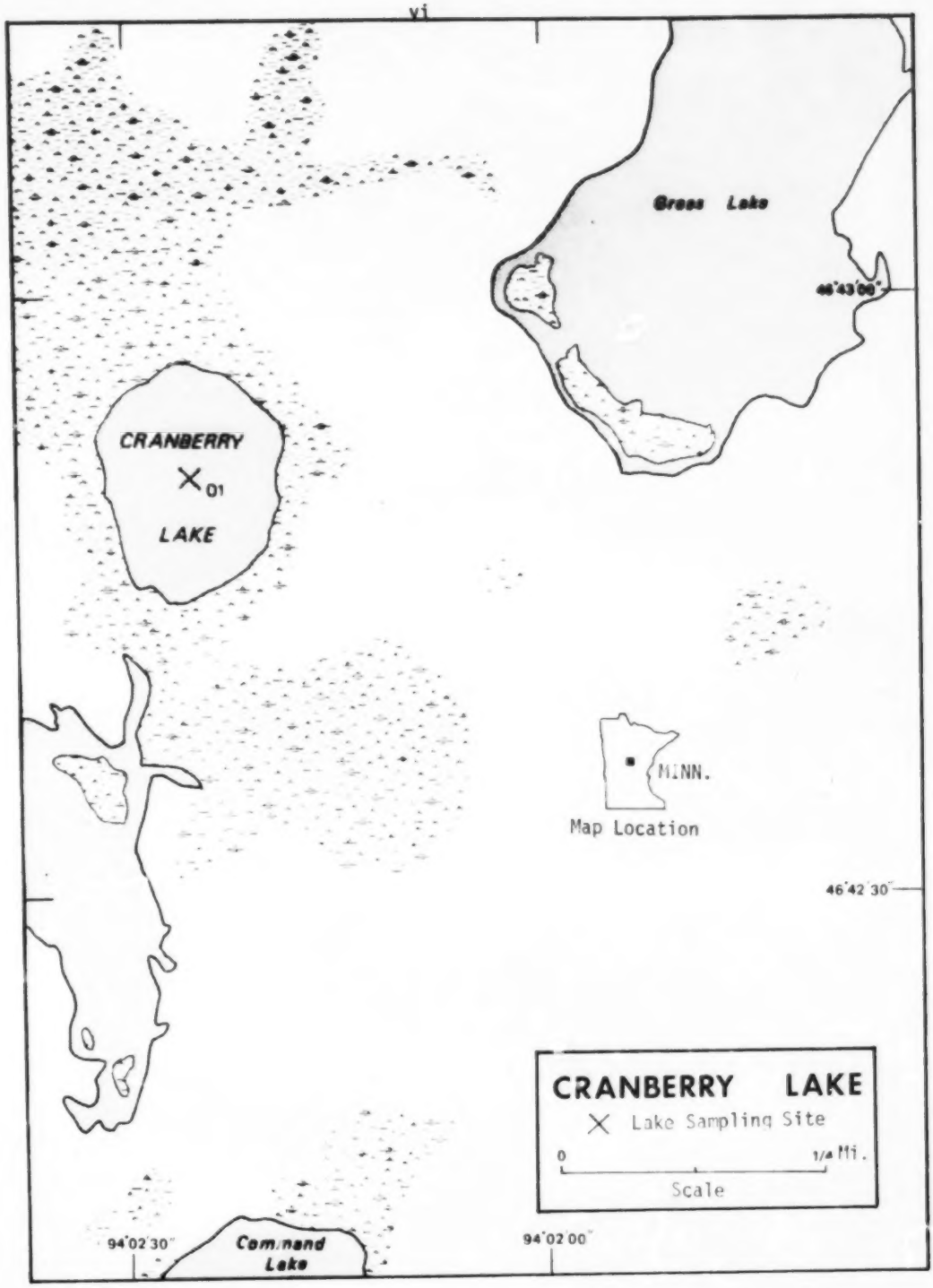
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Grass Lake
46°43'00"
CRANBERRY
X01
LAKE
MINN.
Map Location
46°42'30"
CRANBERRY LAKE
X Lake Sampling Site
0
1/4 Mi.
Scale
94°02'30"
Command Lake
94°02'00"

CRANBERRY LAKE

STORET NO. 2720

I. INTRODUCTION

Cranberry Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and nutrient sources were not evaluated. Therefore, this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data show that Cranberry Lake is eutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, nine had less mean total phosphorus, 12 had less mean dissolved phosphorus, and 26 had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, 52 had less mean chlorophyll a, and 39 had greater mean Secchi disc transparency. Dissolved oxygen was nearly depleted at 30 feet in September, 1972.

Phytoplankton counts were relatively high, and blue-green algae were dominate in the September and October samples.

B. Rate-Limiting Nutrient:

A 38% loss of dissolved phosphorus occurred in the algal assay sample between the time of collection and the beginning of the assay, and the results are not indicative of conditions in the lake at the time the sample was taken (10/24/72).

The lake data indicate nitrogen limitation in July (N/P ratio = 8/1) and October (N/P = 11/1) but phosphorus limitation in September (N/P = 35/1).

III. LAKE CHARACTERISTICS

A. Morphometry:

1. Surface area: 20 acres*.
2. Mean depth: unknown.
3. Maximum depth: >30 feet (based on Survey sampling).
4. Volume: unknown.

B. Precipitation**:

1. Year of sampling: 28.8 inches.
2. Mean annual: 24.8 inches.

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* Anonymous, 1968.
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Cranberry Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at a single station on the lake (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll a analysis. During the last visit, a single five-gallon depth-integrated sample was taken for algal assays. The maximum depth sampled was 30 feet.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/24/72)		
Temperature (Cent.)	5.1	5.2	5.2	5.2
Dissolved oxygen (mg/l)	8.8	8.9	8.9	9.0
Conductivity (μmhos)	108	111	111	115
pH (units)	7.0	7.0	7.0	7.2
Alkalinity (mg/l)	41	42	42	42
Total P (mg/l)	0.017	0.025	0.027	0.030
Dissolved P (mg/l)	0.011	0.016	0.015	0.020
NO_2 + NO_3 (mg/l)	0.030	0.030	0.030	0.030
Ammonia (mg/l)	0.150	0.153	0.150	0.160
		ALL VALUES		
Secchi disc (inches)	14	46	45	80

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/02/72	1. Flagellates	9,140
	2. Synedra	1,448
	3. Fragilaria	1,448
	4. Cryptomonas	498
	5. Dinobryon	226
	Other genera	588
	Total	13,348
09/04/72	1. Oscillatoria	1,989
	2. Microcystis	922
	3. Melosira	199
	4. Anabaena	199
	5. Flagellates	199
	Other genera	760
	Total	4,268
10/24/72	1. Anabaena	1,759
	2. Scenedesmus	1,281
	3. Flagellates	955
	4. Pediastrum	678
	5. Dinobryon	502
	Other genera	1,383
	Total	6,558

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/02/72	01	45.1
09/04/72	01	32.8
10/24/72	01	12.6

V. LITERATURE REVIEWED

Anonymous, 1968. An inventory of Minnesota lakes. Bull No. 25, MN Cons. Dept., St. Paul.

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

272001
46 23 55.0 093 46 33.0
CRANBERRY LAKE
27 MINNESOTA

11EPALES 2111202
3 0003 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	10 30	0000	22.3	6.2	14	60	7.20	19	0.090	0.120	0.168	0.025
72/09/04	14 10	0000			80	87	7.30	33	0.100	0.140	0.024	0.027
	14 10	0004	18.3	5.8		80	7.35	30	0.090	0.100	0.021	0.013
	14 10	0015	10.6	0.7		120	6.85	50	0.090	0.140	0.027	0.009
	14 10	0030	4.5	0.3		160	6.70	65	0.110	1.610	0.029	0.018
72/10/24	15 45	0000			45	115	7.20	42	0.030	0.150	0.017	0.011
	15 45	0004	5.2	9.0		112	7.00	42	0.030	0.150	0.026	0.014
	15 45	0015	5.2	9.0		112	7.00	42	0.030	0.150	0.030	0.019
	15 45	0020	5.2	8.8		110	7.00	41	0.030	0.150	0.029	0.020
	15 45	0025	5.1	8.9		108	7.00	42	0.030	0.160	0.030	0.017
	15 45	0030	5.1	8.8		110	7.00	41	0.030	0.160	0.021	0.014

9.

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	10 30	0000	45.1J
72/09/04	14 10	0000	32.4J
72/10/24	15 45	0000	12.6J

J VALUE KNOWN TO BE IN ERROR